System and Method for Conveying Enhanced Visually Perceptible Cues to an Observer

Cross-Reference to Related Applications

[0001] This application claims priority to and benefit of, and incorporates by reference, U.S. Provisional Patent Application No. 60/447676, filed on 14 February 2003.

Background

[0002] In many contexts, it is desirable, or even required, to convey color-coded information to an observer, often for safety purposes. For example, at an airport, there are potential hazards to workers who may come into proximity of moving aircraft or airside vehicles, such as fuel trucks. Such workers often are required to wear highly visible clothing, so observers operating the moving vehicles can readily discern the presence of the workers, thereby avoiding collisions that may result in injury or death. Such workers generally wear vests having an orange color, possibly with reflective silver stripes.

[0003] Similarly, during a hunting season, especially in popular terrains, there is a danger that a hunter may be mistaken for a game animal by another hunter, potentially resulting in an accidental shooting, causing injury or death. It is important for a hunter to distinguish another hunter from the ambient environment of the hunting terrain. Therefore, hunters often wear vests having a color highly visible to an observer equipped with ordinary color vision; a widely used color for such vests is blaze orange.

[0004] Traffic is another context in which signs and lights often use colors ranging from red to orange to yellow to green, to convey any of various safety-related cues to drivers and pedestrians. For example, many a road sign is predominantly red, amber, or green in color. Vehicle turn signals are generally amber or red. And traffic lights are generally red, amber, and/or green.

[0005] However, the safety colors used by the prior art suffer from a serious drawback. Approximately one of every twenty five people suffers from red-green color-blindness. Six to eight percent of the male population is red-green color-blind, and a non-negligible

portion of the male population is incapable of differentiating the hue of safety-orange from the hue of many common backgrounds such as leaves or grass. Similarly, the ability of many observers to respond to, for example, safety-orange traffic signals is hindered by color-blindness.

[0006] A red-green color-blind observer generally is unable to distinguish between green and red, as well as yellow and any of the shades of orange which are formed from combinations of red and green. Consequently, the colors employed by the prior art safety devices do not enable a color-blind observer to discriminate the safety devices from ambient surroundings. Therefore, there exists a need for improved safety devices, employing visually perceptible cues for color-blind observers.

Summary of the Invention

[0007] The invention addresses the deficiencies in the prior art by providing, in one embodiment, systems and methods of providing visually perceptible cues for color-vision deficient (herein referred to as "color-blind") observers. In other embodiments, the invention relates to devices that employ such visually perceptible cues, along with methods of making and using such devices.

[0008] More particularly, in one aspect, the invention provides a safety indicator having a first safety color highly visible to an observer having substantially ordinary color vision, and a second color more perceptible by blue-sensitive photoreceptors of a retina of the observer than by other photoreceptors of the retina.

[0009] According to one embodiment, at least one of the first safety color and the second color is produced, at least in part, by a primary light source. A primary light source is a light source that emits its own light, such as, without limitation, the sun, a turned-on light bulb, a flame of a lit candle, and the like.

[0010] In an alternative embodiment, at least one of the first safety color and the second color is produced, at least in part, by a secondary light source. A secondary light source does not emit its own light; rather, a secondary light source reflects or diffuses incident light produced by another light source. For example, a side-panel reflector on an outer surface of an automobile generally includes material that reflects red and/or amber portions of the light spectrum.

[0011] In yet another embodiment, at least one of the first safety color and the second color is produced, at least in part, by a combination of a primary light source and a secondary light source. For example, the plastic cover of an automobile's turn signal indicator generally includes a partially-translucent material that not only colors the substantially white light emitted by the turn signal light bulb, but also diffuses such light, thereby producing a diffused amber and/or red color seen by observers, e.g., drivers in other vehicles and pedestrians.

[0012] According to one embodiment, the first safety color includes a combination of red and green. An exemplary combination produces, without limitation, one or more of orange/amber, yellow, yellow-green, or the like. A safety-orange color is understood to be highly visible to an observer having substantially ordinary vision, and therefore effective at indicating the presence of an individual, such as a jogger running along a road, or a hiker walking through a wooded area. More generally, the first safety color may include one highly visible color or a combination of a plurality of highly visible colors. As used herein, "highly visible color" refers to any one or more of a number of commonly used safety colors, such as, without limitation, fluorescent red, fluorescent yellow, fluorescent orange, fluorescent lime-green, fluorescent yellow-green, blaze orange, amber, yellow, green, red, and the like.

[0013] According to one embodiment, the first safety color includes a wavelength greater than about 500 nanometers, generally corresponding to a range of the electromagnetic spectrum containing substantially non-blue electromagnetic waves. In one variation, the first safety color includes a wavelength between about 500 nanometers and about 700 nanometers, generally corresponding to a range of the visible light spectrum containing substantially non-blue light.

[0014] More particularly, in one variation, the first safety color includes a wavelength of about 535 nanometers. In an alternative embodiment, the first safety color includes a wavelength between about 500 nanometers and about 570 nanometers, generally corresponding to a range of the visible light spectrum including the color green. In another exemplary application, the first safety color includes a wavelength of about 580 nanometers. In one variation, the first safety color includes a wavelength between about

570 nanometers and about 590 nanometers, generally corresponding to various hues of yellow, ranging from greenish yellow, to yellow, or orange-yellow.

[0015] In an exemplary variation, the first safety color includes a wavelength of about 600 nanometers. In another exemplary variation, the first safety color includes a wavelength between about 590 nanometers and about 610 nanometers, generally corresponding to a range of orange hues.

[0016] In another variation, the first safety color includes a wavelength between about 610 nanometers and about 700 nanometers, generally corresponding to the portion of the visible light spectrum substantially associated with the color red.

[0017] The wavelength of a color is referred to herein as the wavelength of the reflected light, the wavelength of the diffused light, and/or the wavelength of the emitted light associated with the color, and generally is a function of whether the color is produced by a primary light source, a secondary light source, or a combination thereof.

[0018] According to one embodiment, the second color includes a wavelength of less than about 500 nanometers. In one variation, the second color includes a wavelength between about 350 nanometers and about 500 nanometers, generally corresponding to a range of the light spectrum including various hues of blue and purple. In another particular variation, the second color includes a wavelength of about 450 nanometers. In another exemplary variation, the second color includes a wavelength between about 430 nanometers and 500 nanometers. In one embodiment, the second color includes indigo blue.

[0019] Preferably, the first safety color covers more of an area visible to the observer than does the second color. In some exemplary configurations, the second color covers less than about 50%, 40%, 30%, 20%, or even 10% of the area visible to the observer.

[0020] While the second color may be calibrated particularly for the retina of a human observer, in alternative embodiments, the second color may be calibrated for the visual system of any animal, including, without limitation, other primates, mammals, fish, amphibians, birds, reptiles, insects, or the like.

[0021] In one aspect, the invention provides an article of clothing including the first safety color and the second, color-blind perceptible, color. Articles of clothing may include, without limitation, any garment, such as: hats, helmets, scarves, headbands or

other headwear; coats jackets, vests, shirts or other apparel associated with a torso; pants, chaps, or other legwear; shoes, boots, sneakers, wheeled skates, ice skates, or other footwear; gloves, armbands, or other handwear or armwear; and other wearable insignia.

[0022] In a further aspect, the invention provides a vehicle including the first safety color and the second, color-blind perceptible, color. Examples of vehicles include, without limitation, landcraft, watercraft, and aircraft, including motorcycles, bicycles, tricycles, strollers, skateboards, wheelable carts, and/or rolling rideable toys for children.

[0023] In one variation, one or both of the first safety color and the second, color-blind perceptible, color are applied to the surface of the vehicle, such as in the form of a coating or laminate, including, without limitation, paint, enamel, polish, or others. According to another construction, either or both of the colors are mounted to the vehicle, such as, for example and without limitation, in the form of a colored patch or emblem.

[0024] According to another practice, the vehicle includes at least one light source for providing either or both of the first safety color and the second, color-blind perceptible, color. Without limitation, an exemplary embodiment includes a vehicle having a turn signal providing both an amber light as the first safety color, and a blue light as the second, color-blind perceptible, color. Similarly, the stop lights of a vehicle may be configured to emit both the first safety color (e.g., red) and the second, color-blind perceptible, color (e.g., blue).

[0025] According to another aspect, the invention provides an insignium including the first safety color and the second, color-blind perceptible, color. By way of example, the insignium may include an article of signage, such as, without limitation, a traffic/road sign, a traffic light, a warning sign, a warning light, an indicator light (depicting, for example, that an intended lane change or turn), a road pavement marking, an identification sign, a commercial sign, or other kinds of insignia.

[0026] The insignium, according to one embodiment, may be wearable, such as a patch, label, or emblem on an article of clothing. In one practice, the insignium may be affixed to the safety indicator, the article of clothing, or the vehicle by an adhesive such as glue, by sewing, by knitting, by Velcro, by lamination, by electroplating, or by any other coating or the like.

Brief Description of the Drawings

[0027] The following figures depict certain illustrative embodiments of the invention, in which like reference numerals refer to like elements. These depicted embodiments are illustrative of the invention, not necessarily drawn to scale, and should not be considered as limiting in any way.

[0028] Fig. 1 depicts a hunting vest having a blue stripe running along sides of a front of the vest to enhance discrimination by a color-blind observer, according to an illustrative embodiment of the invention.

[0029] Fig. 2 depicts an indicator light having an amber or red color in an outer region, and a blue indicator light in an inner region, according to an illustrative embodiment of the invention.

[0030] Fig. 3 depicts a traffic cone colored mostly in safety orange, and also having stripes of blue to enhance discrimination by a color-blind observer, according to an illustrative embodiment of the invention.

[0031] Fig. 4 depicts a stop sign having a red background, white lettering, and a blue marginal stripe outlining the shape of the sign, according to an illustrative embodiment of the invention.

Description of Illustrative Embodiments

[0032] As discussed above, the invention, in one embodiment, discloses devices and methods of providing visually perceptible cues to a color-blind observer, addressing a failure of the prior art to provide such visually perceptible cues. The systems and methods described herein take advantage of the fact that blue color-blindness is extremely rare, and hence uses a hue of blue to augment the visibility of a variety of safety-related devices for a sizable portion of the population of color-blind observers.

[0033] In a human, the sensation of color is produced when light strikes a canvas of photoreceptor nerve cells, known as cones, in the retina of an eye. Cones come in three varieties: red, green, and blue. Red light stimulates the red cones, simultaneously inhibiting the surrounding green cones. Green light creates a substantially opposite effect, stimulating the green cones and inhibiting the red cones. Blue light stimulates the blue cones, inhibiting both the green and the red cones. The variety of colors that the

human eye perceives is a combination of the three primary colors of red, green, and blue, the sensation being produced by the activity of the corresponding cones in the retina.

[0034] The ability to see in color is rare among vertebrates. Whereas humans and other primates do see in color, most other mammals do not. This can work to advantage in a hunting setting, for example, where a vest constructed according to the methods and systems described herein would be visible to a color-blind human observer, but can be camouflaged from color-blind deer.

[0035] Most fish and amphibians do see in color, as do some birds and reptiles. Insects mostly are not possessed of color vision, with at least two prominent exceptions; bees and butterflies do have the ability to see in color.

[0036] Although there are many variations of color-blindness in humans, the most common is red-green color-blindness. Individuals suffering from red-green color-blindness do not have fully-functioning red cones and/or fully-functioning green cones. Their ability to distinguish between green and red—and hence a combination of green and red by which other colors such as orange and yellow are produced—is inhibited. As mentioned above, blue color-blindness is rare, and this is taken advantage of by the systems and methods described herein.

[0037] Fig. 1 depicts one embodiment of the invention is presented wherein a hunting vest **10** is depicted as having a blue stripe **12** running along the sides of the front of the vest, and, optionally may form a pattern on the back of the vest as well (not shown). Color-blind observers, including those who are red-green color-blind, perceive hues of substantially blue, and that a substantially blue hue is not a color that normally occurs in natural, ambient surroundings. Accordingly, the stripe **12** depicted in Fig. 1 may be a blue color having a wavelength somewhere in the range of about 450 nanometers. Thus, the stripe **12** of the vest **10** reflects a blue that may be readily differentiated from most backgrounds by a color-blind observer. A highly visible color, such as safety-orange, for example, surrounding the blue stripe **12** is readily perceived by an observer having substantially ordinary color vision. Observers having substantially ordinary color vision can also detect a substantially blue hue.

[0038] Fig. 2 depicts a further embodiment of the invention is presented. Specifically, Fig. 2 depicts an indicator light **20**. The indicator light, preferably, is colored safety-

orange/amber or red, and may be activated to indicate a warning (such as in an emergency condition), the location of an emergency exit, traffic signal information to stop or slow down, intention by the driver of a vehicle to commence a turn or change lanes, or some other information. As discussed above, observers having substantially ordinary color vision can discern an orange- or red-colored warning light **20**. However, the ability of a color-blind observer to do so is substantially hindered; in fact, a color-blind observer may be incapable of differentiating an orange or red light from other lights, such as green or yellow that might denote normal, non-emergency, conditions.

[0039] To this end, the warning light **20** includes a region **22** that, in one embodiment, produces a spectrally pure blue. As described above, a spectrally pure blue, or a substantially pure blue, is generally properly perceived by a color-blind observer, and therefore can indicate to the color-blind observer that indicator light **20** is active. Such lights may be employed as traffic lights, toll booths signals, lights at emergency exits, safety lighting at construction sights, vehicle turn signal lights, or for other applications.

[0040] Although the embodiment of Fig. 2 depicts a concentric circle geometric pattern, the systems and methods of the invention may employ alternative geometric shapes and lettering, without departing from the scope of the invention. For example, an exit sign may have the "EXIT" lettering in a red or orange and have a blue outline along the periphery of each letter.

[0041] The blue color may be achieved by any suitable technique and/or device. For example, in some embodiments, a blue filter may be employed, while in others blue LEDs or some other technique may be used. The technique employed will depend, at least in part, on the application at hand. For example, in a warning light that uses LEDs of red, green, or yellow, the systems described herein may dispose blue LEDs within light. Other embodiments may be employed without departing from the scope here of.

[0042] Fig. 3 depicts a traffic safety cone **30** according to an illustrative embodiment. The traffic cone **30** includes a predominant surface area, denoted by **32a–32d**, which has a high visibility color for an observer having substantially ordinary color vision. However, as shown in Fig. 3, the traffic cone **30** has been modified to include a smaller surface area, denoted by the ring-shaped regions **31a–31c**, configured to produce a substantially blue hue, visible to most color-blind observers. Although the blue regions

31a–31c are depicted substantially horizontally in Fig. 3, in other embodiments the blue regions may be disposed differently, such as, for example, substantially vertically along the surface of the cone **30**.

[0043] The blue regions **31a–31c** may be produced in a number of ways. For example, in one variation, the blue regions **31a–31c** are produced by application of a coating of substantially blue hue to the traffic cone **30**. In another variation, the regions **31a-31c** are produced by application of strips of blue tape, having an adhesive on one surface, to the traffic cone **30**. In another illustrative embodiment, the regions **31a-31c** are made of a substantially retroreflective substance to increase visibility. A retroreflective substance reflects radiation, such as light, so that paths of reflected rays are substantially parallel to the paths of the incident rays. In another illustrative embodiment, the blue regions **31a–31c** are produced by one or more fluorescent colorants to create an indigo blue hue to enhance the visibility of the cone **30**.

[0044] Fig. 4 shows a traffic sign **40** according to an illustrative embodiment of the invention. More particularly, the traffic sign **40** is a stop sign modified to enhance discrimination by a color-blind observer. The stop sign **40** is predominantly covered by an area **41** having a substantially red hue. In a typical embodiment, the lettering "STOP" **43** is designed to produce a color that is substantially white. A modification, according to an embodiment of the systems and methods described herein, to increase discrimination of the traffic sign **40**, is to dispose a strip **42**, having a substantially blue hue, along the perimeter of the stop sign. A color-blind observer, therefore, may use the octagonal shape of the strip **42** to more readily discern the indication to stop conveyed by the traffic sign **40**. In another embodiment, the lettering **43** may be modified to have a substantially blue outline for easier readability by a color-blind observer. According to one variation, the strip **42** includes a retroreflective substance for enhance visibility. The strip **42** may also include a fluorescent blue hue, according to an exemplary variation. According to another embodiment, the traffic sign **40** is a self-luminous stop sign. In one variation, a self-luminous stop sign is illuminated with a light source including glass tubes coated with phosphor and filled with tritium gas H-3, an isotope of hydrogen that emits low-energy beta ray ionizing radiation having negatively-charged electrons. The electrons stimulate the phosphor coating, causing the tubes to continuously emit light. Other

modifications may be employed in alternative embodiments, without departing from the scope hereof.

[0045] Although the systems and methods described herein have been described with reference to embodiments showing a hunting vest, an indicator light, a traffic safety device, and a traffic sign, the devices and methods of the invention are not so limited. Instead, the embodiments depicted and described herein are primarily for illustrative purposes. In particular, the systems and methods described herein are not limited to any particular kind of warning lights, or safety garments, warning devices or signage. For example, vests, coats, hats, jumpsuits and other articles of clothing can be modified as described herein to provide a visual indicator perceptible by a color-blind observer. These garments can be made of any conventional fabric, including, without limitation, nylon, canvas, and cloth. Additionally, these articles of clothing can be made by any suitable technique, including sewing a patch onto an existing vest or coat, dying a portion of the vest or coat with the desired color, or by temporarily attaching a patch or stripe to an article of clothing wherein the patch or stripe may be held in place by a hook and loop fastener, Velcro, or other such fasteners. Generally, the embodiments described herein have been described with reference to adding a blue hue to a device to enhance visually perceptible cues to an observer, in particular a color-blind observer.

[0046] While the above illustrative description has been provided in terms of a human observer, other non-human applications of the invention exist. For example, in alternative embodiments, the second color may be calibrated for the relevant portion of the visual system (e.g., retina) of any animal, including, without limitation, other primates, mammals, fish, amphibians, birds, reptiles or the like. The second color may also be calibrated for the visual system of any of numerous small invertebrate animals (such as spiders or centipedes) having color vision, such as, without limitation, those that fall into the class of insects, including bugs, butterflies, and bees. Moreover, the phrase "ordinary color vision" as used herein is defined in reference to the observer. Namely, it is understood that what is considered to be "ordinary color vision" for a human may not be the same as "ordinary color vision" for another primate or an insect, for example.

[0047] Additionally, while in some embodiments, the safety device is particularly intended for providing visually perceptible cues to color-blind humans, in alternative

aspects, the methods and devices of the invention may be employed for providing visually perceptible cues to any observer, such as the above listed organisms. Related aspects may be employed, for example, to repel non-human observers from a particular location. For example, the invention may be employed for repelling insects from humans, or for dissuading birds from flying into undesirable locations, such as aircraft engines, or transparent barriers, such as windows. As a further example, the invention may be employed for attracting non-human observers to a desirable location, such as for attracting birds to bird feeders, or animals to hunting blinds.

[0048] Accordingly, the invention is not to be limited to the embodiments, aspects, and practices disclosed herein, but is to be understood from the following claims, which are to be interpreted as broadly as allowed under the law.

[0049] What is claimed is: